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ABSTRACT

The purpose of the study was to determine the readability level and the level of involvement for selected science textbooks for grades 7-10. A review of related literature concerning readability scales and the Romey Index is included. Thirty secondary science texts were evaluated using the Fry Readability Graph and Romey's Involvement Index. The resulting data included expected grade placement of the text, calculated reading average level, reading level range and Romey Involvement Level. The results indicated a considerable range of readability level within some textbooks as well as from one text to another. Evidence also indicated that a few texts had readability levels consistently equal to or less than the grade level recommendation while some had readability levels ranging into the college level. The Romey Index of Involvement appeared to be a valid measure of the inquiry orientation of textbooks because of the consistency of the results. (Author/BR)

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An Application of Romey's Involvement Index and a Standard Reading Formula to Representative "Modern" and "Traditional" Science Textbooks for Grades 7-10

A Paper
Presented to the
Southern Area Convention
of the
National Science Teachers Association
Memphis, Tennessee

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INTRODUCTION

The teaching of science or any other subject is generally as effective as the student's ability or willingness to comprehend. It has been known for many years that individuals use only a small part of their inate ability for learning. Good teachers are probably more successful in leading students toward intrinsic motivation than are other teachers. However, no matter how much desire the student has for learning or how much effort the teacher expends, students are sometimes incapable of reading what is presented or written. More important students may call words and still not comprehend their meaning. Spache states that "in the strict sense of the term, a person cannot be said to be reading unless he also comprehends." (Spache, p.61)

It is common knowledge that significant positive correlations exist between measures of IQ and reading scores. A discussion of specific intelligence factors which lead to greater comprehension is beyond this report. Spache indicates that evidence supports the "belief that intellectual factors are important components of comprehension." (Spache, p.64) He further notes that as the number and complexity of concepts increase comprehension decreases and that "reading materials are simplified only by reorganization and simplification of the relationships among the concepts presented." (Spache, p.64) Thus it appears that an intensive study of the readability levels of many of the common secondary level science texts would be of value when

selecting books for particular student groups.

A considerable effort has already been made by Kennedy to provide readability scores for a selected number of contemporary science texts at the junior high school level. (Kennedy, pp.26-27) This investigation will replicate some of the work done by Kennedy and supply additional readability scores on a number of the more conventional and widely adopted texts for grades 7-10. In addition, another measure entitled index of student involvement is included. This index initiated by Romey involves the computation of a ratio of inquiry and/or involvement to factual or general information. (Romey, pp.44-51) According to Romey a value of 0 represents no involvement while values above 0 represent an increasing amount of involvement with the best balance between 0.4 and 1.5. (Romey, p. 47) This index seems appropriate for evaluating textbooks if one considers the importance of student involvement in the teaching of science and the influence a particular text has on the way science is presented in the classroom.

PURPOSE OF INVESTIGATION

The purpose for this investigation was to determine the readability level and the level of involvement for selected science textbooks for grades 7-12.

REVIEW OF RELATED LITERATURE

The choice of the Fry readability graph for this investigation was based on both its simplified procedure as well as

its acceptability as a respectable method for arriving at an index of readability. (The selection of this method over that of a number of available quantitative methods has to be, to some degree, arbitrary.) Some of the first scales were developed by Maxwell in 1921, Spaulding in 1922, Franzen and Knight in 1922, Fuller in 1928, Whipple in 1936, Underwood in 1941, and Clement in 1942. (Harris, pp. 1517-1524) Two of the more recent and widely accepted formulas were developed by Dale and Chall and Spache. (Fry, p.205) Fry followed the same parameters as the Dale-Chall and the Spache formulas, using vocabulary difficulty and sentence length, while adapting these parameters to a graph. (Fry, p.206) He reported correlations of 0.98, 0.78, 0.94, 0.96 and 0.93 between the Fry Readability Graph and the SRA, Rotel, Dale-Chall and Flesh formulas and a mean of student comprehension respectively. (Fry, pp.233-235)

When results from the Fry Graph are compared to the results from the Dale-Chall and other formulas there seems to be an indication that the Fry Graph may produce more conservative or lower grade level indices. Fry noted that his formula gives about the same grade level designations but that the Dale-Chall rates some books a little harder. (Fry, p.233) Weintraub reported comparisons of readability where the Dale-Chall and Fog methods were applied to materials for basic adult education courses. He concluded that the Fog and Dale-Chall formulas overrated and the Fry Graph underrated the publisher-suggested level. (Weintraub,

et.al.,p.275) These results may be related to the concern expressed by many writers that the Dale-Chall and other vocabulary lists are somewhat out of date. The Fry Graph does not depend on a particular list of words, only on the number of sentences and the number of syllables in a selected 100 word passage.

An interesting presentation by Wall depicts a number of levels of understanding and their relationship to student comprehension. He indicated that for a student to comprehend at the 90 percent level he must immediately recognize about 99 percent of the contextual words and to comprehend 75 percent of the material, the student must recognize and pronounce correctly 95 percent of the words in the context. (Dechant, pp.70-71) Wall refers to the 75 percent level of comprehension as the instructional "level of difficulty which will offer optimal challenge to the reader, provided he is supervised." (Dechant, p.71) One grade level of readability above the instructional level is described by Wall as the frustration level where the student, under supervised instruction, will fall below 50 percent accuracy in comprehension. At this level the student will recognize no more than 90 percent of the words on sight. (Dechant, p.71) Wall further supports multi-level text materials when he states that "it makes no more sense to have all class members read from the same text, readability-wise than it does to have all tenth graders take geometry... (Dechant, p.72)

The choice of the Romey Index of Involvement is somewhat arbitrary since there are few quantitative methods for analyzing the degree wo which textbooks promote student involvement. This seems to be a particularly important aspect of a textbook since there is little doubt but what the materials and presentation of the text influence the teaching process of many teachers.

The details of the Romey Index are too elaborate to reproduce for this presentation, so an attempt to describe the basic ingredients for the formula is made. Essentially the process requires one to randomly select ten different places in a given textbook and classify twenty-five sentences according to ten possible categories. The first four categories include statements which are facts, conclusions, definitions and questions answered immediately by the text. The sum of these four classifications are entered as the denominator of the formula. The next four classifications include questions requiring the student to analyze data, statements requiring the student to formulate conclusions, directions to students requiring them to analyze and perform activities or solve problems, and questions designed to arouse interest. These are summed and constitute the numerator of the equation. The ratio of the involvement to factual (numerator to denominator) becomes the measure of involvement. (Romey, p.45) Rhetorical questions, directions of procedure and other items such as chapter introductions, paragraph headings and summary questions are excluded from the analysis. (Romey, p. 44-45)

The presentation of research evidence which substantiates the need for analyzing textbooks in science coupled with the wealth of opinion, some based on considerable experience, which is being spoken and written offers evidence that more work is needed in this area. The past five years have been fruitful in productivity of materials designed especially for students with one problem or another. Whatever the learning difficulty,there seems to be the ever present relationship of the problem to reading deficiency. Bloom generalizes from the IEA (International Association for the Evaluation of Educational Achievement) studies that reading comprehension and word knowledge or "verbal education" tends to dominate and determine what students learn in schools in all countries and that the success and ultimate survival of students in school is dependent on the early development of verbal ability. (Bloom p.422) Bloom also reports a correlation attained from the IEA studies between science and reading comprehension of .68, .60 and .44 respectively for students at ages 10, 14 and their final year of secondary school. (Bloom, p.421)

A number of recent studies have been completed which compare the effects of different science programs on the development of reading skills, especially in the elementary school. The results from one somewhat representative study by Heath lead to the conclusion "that contemporary elementary science instructional programs promote the development of science reading skills and

abilities to a significantly greater extent than those programs which are textbook oriented." (Heath, p.5667-A) Berne also found that students in the IPS program "developed more significantly the aptitudes of verbal reasoning, numerical ability and space relations" than did students in a conventional course. (Berne, p.4573-A)

Another concern relating to the calculation of the readability of a science textbook is the degree to which the scientific vocabulary inflates the readability level. This presentation includes the analysis of approximately 35 books and no attempt was made to exclude or consider the influence of scientific vocabulary. It is assumed by this writer that the exclusion of scientific terms would result in an inadequate description for textbooks. The high degree of terminology probably does inflate the readability of science textbooks over textbooks from other disciplines. This is consistent with the findings of Davis who reports that "seven selected eighth grade science texts were found to be approximately three grade levels of reading difficulty above three eighth grade social science and English texts. (Davis, p.7513-A)

Davis also paraphrased the technical presentation of particular textbooks thereby reducing their scientific verbal levels. A comparison was made between students who used the paraphrased materials and students who used the regular textbooks. The

results for the investigation revealed that "students who were exposed to the low verbal treatment scored high in all comparisons, although not significantly, than those exposed to the technical verbal treatment." (Davis, P.7513-A)

The apparently strong relationship which exists between comprehension of scientific materials and readability level of the materials offers support for thoroughly investigating the reading level of all science textbooks. The emphasis on teaching science as a process of inquiry has been well established for a number of years. Therefore, the readability and involvement measures described above are presented in the following pages.

READABILITY AND INVOLVEMENT RESULTS

PUB.	TEXTBOOK TITLE	EXPECTED GRADE PLACEMENT OF TEXT	CALCULATED READING AVERAGE LEVEL	READING LEVEL RANGE	ROMEY INVOLVEMENT LEVEL
HM	Man and the Environment-Life Science	7	6-7	3-9	.64
RMc	Interaction of Man & the Biosphere	7	10	6-Col	.42
McG	Challenges to Science-Life Science	7	6-7	4-9	.11
PH	ITS Life Science	7	3	1-7	.75
CM	Focus on Life Science	7	8-9	7-12	.19
HRW	Modern Life Science	7	6-7	6-7	.19
HRW	Modern Earth Science	8-9	11	7-Col	.06
RMc	Interaction of Earth & Time	8-9	9	6-11	.48
SB	Earth Science	8-9	7-8	5-9	.11
CM	Focus on Earth Science	8-9	11-12	7-Col	.11
HM	Investigating the Earth	8-9	9	6-12	.39
McG	Earth Science-Challenges to Science	8-9	8	6-10	.17
HRW	Modern Physical Science	8-9	8-9	5-Col	.09
PH	Physical Science IIS	8-9	7	4-8	.97
CM	Focus on Physical Science	8-9	9-10	7-Col	.24
RMc	Interaction of Matter & Energy	8-9	7	4-10	1.12
PH	Introductory Physical Science	8-9	9-10	8-11	.37
PH	Physical Science II	9-10	9-10	7-12	.71
McG	Challenges to Science Physical Science	8-9	7	3-11	.21
SB	Vol I Probing the Natural World(ISCS)	7	7-8	6-9	.66
SB	Vol II Probing the Natural World (ISCS)	8	6-7	5-8	1.08
SB	ISCS Crusty Problems	9	7-8	6-11	.53
	Investigating Variation	9	8	4-Col	.79
	What's Up?	9	6	5-7	.41
	In Orbit	9	8	6-12	.49
	Environmental Science	9	9	3-Col	.79
	Well Being	9	6	3-9	.60
	Winds and Weather	9	7-8	5-Col	1.1
RMc	Biological Science Ecol. Approach(BSCS)	10	11	8-12	.28
PH	IIS Biology	10	6	4-Col	.70
HM	Biological Science Molecules to Man(BSCS)	10	12	6-Col	.08
SB	Biology	10	11	7-Col	.10
CM	Biology	10	Col	11-Col	.05
HRW	Modern Biology	10	9	8-11	.01
PH	Foundations of Biology	10	11	9-Col	.01
HBG	Biol. Science - Inquiry Into Life(BSCS)	10	[illegible]	6-11	.27

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The results from this investigation reveal that a considerable range in readability level is present within a particular textbook as well as from one text to another. Evidence also indicates that a few of the texts have readability levels consistently equal to or less than the grade level for which they are recommended while a number have greater readability levels, some ranging into the college level.

It is the opinion of this writer, based on the previous review of the literature, that those texts which average grade level and below and which seldom range above grade level are suitable for use with students who have consistently performed at about their grade level or below. These students should not be placed in classes where textbook materials are of generally higher than grade level readability unless a planned emphasis on vocabulary development is to be implemented. Students with above average performance records will probably be successful in classes regardless of choice of text. However, textbooks which are consistently rated as having above average readability levels as compared to their recommended placement should be used with discretion, if at all.

The Romey Index of Involvement appears to be a valid measure of the inquiry orientation of textbooks as evidenced by the general consistency of the results. It appears that the index adequately discerns between textbooks which are known to be rated high in involvement influence and those considered less inquiry oriented. If involvement is the concern of the teacher, it appears that a number of the textbooks fall within the recommended range of 0.4 and 1.5 and that a number fall considerably short of the range. The major conclusions drawn by this investigator, as a result of the many trials with the Romey Index, are (1) regardless of the intention of the author of the text, the descriptive passages of the texts, with few exceptions, offer little involvement; (2) most of the inquiry in any particular text was a direct result of a laboratory or activity exercise; and (3) textbooks which did not include the laboratory exercises were generally rated low on the involvement scale. When evaluating such textbooks the associated laboratory guides should be considered as well as the textbook proper.

Another fact constantly revealed throughout the investigation was that the writing style of different authors differs immensely. Many authors used lengthy complex sentences which, though well written, inflate the readability level while other

authors use short choppy sentences with many large scientific terms and still hold the readability level within grade placement. The effects of such variation on comprehension would be of interest and could be of sufficient concern to cast doubt on the blind adherence to readability formulas as screening devices for textbook selection.

It is believed that each individual involved in textbook evaluation would benefit in many ways by computing both the readability and the involvement measures. The intensive nature of these investigations reveal considerably more than the numbers derived. A comparison between the results found in this investigation and other raters would be welcomed by this writer.

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